AD-A191 047 AN INTERDISCIPLINARY STUDY OF WAVE PROPAGATION IN RANDOM MEDIA(U) WASHINGTON UNIV SEATTLE SCHOOL OF OCEANOGRAPHY T EWART ET AL. 30 NOV 87 N00014-87-K-0094

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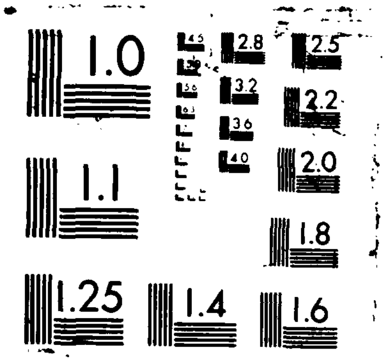
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An Interdisciplinary Study of Wave Propagation in Random Media

Date: 9 Feb. 1988
Principal Investigators: Terry Ewart and Brian Lewis
Contract Number: N00014-87-K-0094
Contract Period: 1 Dec. 1986 - 30 Nov. 1987

Final Technical Report

FY87 was the first year of a two year study involving five different topics. The work described here has been merged with our ongoing ONR program and is now funded under the title Cooperative Ocean Acoustics. Because the research discussed here is only the first year of a two year study, the research is ongoing. The five topics initiated under this contract involve: (1) study of the multidimensional matched filter pulse analysis method and extension to include multiple receivers; (2) modification of the stochastic parabolic equation (PE) codes to include random rough surface scattering; (3) study of the probability distribution of acoustic intensity and extension of our one dimensional distribution to two dimensions; (4) merging of a fully nonlinear internal wave numerical model with the numerical methods based upon the parabolic equation for ocean acoustic propagation; and (5) initiation of source localization studies using the acoustic travel times measured during the AIWEX Acoustic Transmission Experiment (AATE). Finally, we plan to continue our efforts towards the creation of the "Center of Excellence in Acoustics" at the University of Washington.

1. *Multidimensional Matched Filter Pulse Analysis*

During the contract period, considerable improvements were made in the single transducer pulse analysis algorithm reported by Bell and Ewart [B. Bell and T. Ewart *IEEE Trans. Acoust., Speech, and Signal Processing*, ASSP-34(5), 1029-1037 (1986)]. A constrained method has been developed to remove two-pi phase ambiguities. Pulse analysis is more than a factor of two faster than the earlier algorithm. To develop the constraints, initial estimates are needed. During the second year of the program, a multi-transducer version of the algorithm will be studied for the feasibility of removing the need for initial estimates. A formal algorithm is under development that will allow angular as well as the temporal constraints now used.

2. *Merging of the Volume and Surface Scatter Propagation Codes*

Three different marching methods based upon the parabolic equation have been examined for use in studying the scattering of acoustic energy from a rough surface. The methods are 1) a split-step method, 2) a finite-difference technique, and 3) a hybrid method. Of the three methods, the split-step method is being examined further because of its efficiency and compatibility with our volume propagation code. The results from the numerical experiments are compared with those obtained using two integral equation methods developed by Thorsos, an exact [*J. Acoust. Soc. Am.*, in press,Jan 88], and a PE-based method. Volume propagation with a range and depth dependent sound speed profile is included in the marching algorithm along with the rough surface scattering. Detailed study of the split-step method is ongoing.

3. *Probability Distribution of Intensity*

A study of the behavior of the probability distribution of intensity under a wide variety of scattering conditions was completed during FY87. The parameters of the generalized gamma distribution have been related to the acoustic scattering parameters used in theories of acoustic scattering. During FY88, a two-dimensional extension of the generalized gamma distribution will be developed to study the distribution of intensity in depth and time. Results on this work were presented at the May meeting of the Acoustical Society of America.

4. *Acoustic PE/Environmental Numerical Studies*

A numerical technique has been developed by Winters and D'Asaro for producing realistic oceanic internal wave fields. The waves evolve dynamically in ways consistent with the fully non-linear Navier Stokes equation. Under this contract, the wave fields have been used to infer sound speed index of refraction fields for use in numerical experiments of acoustic volume propagation. The index of refraction fields are combined with a background sound speed profile and then input to a PE-based numerical code run on an array processor. The output are acoustic fields at varying ranges and times that are realizations of the internal wave- acoustic scattering stochastic process. A video movie of the perturbation density field and the resulting acoustic intensity distribution as a function of time and space was made in order to better communicate our results.

5. *Source Localization Studies*

A geometrical propagation technique was developed during FY87 that uses the travel times measured during AATE. Using the measured average sound speed profile, rays are propagated from a source to obtain the pulse travel times over a fixed depth range. The source position is varied until the difference between the travel times measured as a function of depth during AATE and the times predicted from the source is minimized using a least-squares functional. The angle the receivers make with the vertical is also allowed to vary so the solved variables include not only the depth and range of the source and but also the tilt of the receivers. A publication will be submitted during FY88.

Publications:

B. Bell and T. Ewart, "Separating multipaths by global optimization of a multidimensional matched filter", *IEEE Trans. Acoust., Speech, and Signal Processing*, ASSP-34(5), 1029-1037 (1986).

T. Ewart, "Acoustic propagation, internal waves and finestructure", *Proc. Inst. of Acoustics, 8*, 17 pp.

T. Ewart and D. Percival, "Forward scattered waves in random media - the probability function of intensity", *J. Acoust. Soc. Am., 80*, 1745-1753 (1986).

Presentations:

T. Ewart, "Modeling the general p.d.f. of intensity in terms of the scattering parameters of WPRM", Acoustical Society of America, May 1987.

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